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Using population matrix modeling to predict AEGIS Fire Controlmen community structure

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

USING POPULATION MATRIX MODELING TO PREDICT AEGIS FIRE CONTROLMEN COMMUNITY STRUCTURE

by

Thomas J. McKeon

December 2007

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13. ABSTRACT (maximum 200 words)

As the USN transitions through its personnel draw down, the need for enlisted communities to manage their manpower resources effectively will increase. The cliché, "do more with less," can be applied to the USN requirement to continue to fulfill its mission obligations with fewer personnel. One community in particular has received Navy leadership's interest; the AEGIS FC community is currently experiencing problems in meeting their sea duty requirements.

Part of effective manpower resource management is predicting the future manpower structure. A Population Matrix with Markov properties was used to develop the AEGIS FC aging model. The goal of this model was to provide an accurate predication of the future AEGIS FC community structure based upon variables. The thesis demonstrates that there are several problems inherent in the AEGIS FC aging model. The model was accurate when predicting in the aggregate but failed to predict the AEGIS FC community structure based on years of service.

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USING POPULATION MATRIX MODELING TO PREDICT AEGIS FIRE CONTROLMEN COMMUNITY STRUCTURE

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As the USN transitions through its personnel draw down, the need for enlisted communities to manage their manpower resources effectively will increase. The cliché, "do more with less," can be applied to the USN requirement to continue to fulfill its mission obligations with fewer personnel. One community in particular has received Navy leadership's interest; the AEGIS FC community is currently experiencing problems in meeting their sea duty requirements.

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I. INTRODUCTION AND BACKGROUND

A. BACKGROUND

On October 29, 2001, Secretary of Defense Donald H. Rumsfeld established the Office of Force Transformation. The events of September 11, 2001, irreversibly changed the world in which the United States Navy (USN) operates, and brought into focus the need for a transformation of the United States Defense Department. As a part of this transformation, the focus of the USN shifted from its traditional blue-water missions to littoral regions and anti-terrorist missions. While the USN continued its forward presence — drug interdiction, joint maneuvers, training exercises and humanitarian obligations — it began to undergo a "Force Transformation." President George W. Bush metaphorically laid out the problems of this transformation:

> The need for military transformation was clear before the conflict in Afghanistan, and before September the 11th ... What's different today is our sense of urgency — the need to build this future force while fighting a present war. It's like overhauling an engine while you're going at 80 miles an hour. Yet we have no other choice.

The "Elements of Defense Transformation" manual lays out the need and end goal of the "Force Transformation."

> In the post-Cold War period, when the U.S. appeared to have no peer competitors, and even more so in the post-9/11 world, where the battlefield appears to have no boundaries, senior defense planners have had to assume that surprise is the norm rather than the exception and build a capabilities-based, rather than threat-based force. Our new defense strategy requires agile, network-centric forces that can take action from forward positions, rapidly reinforce from other areas and defeat adversaries swiftly and decisively,[1]

The modern USN finds itself in a Global War on Terrorism (GWOT) with attenuating financial resources to meet the demands of an expanding mission. These

[1] Director Force Transformation, "Elements of Defense Transformation," Washington, DC: Office of the Secretary of Defense, 2003, 12.

mission expansions in excess of the scarce dollars available have driven a need to find efficiencies where possible. While personnel are the Navy's "most valuable resource," they are also one of its most expensive resources. The Navy's military personnel budget in fiscal year (FY) 2007 is allocated 38 billion dollars of the Navy's 129 billion dollar budget[2]. Weighing in at 29.4 percent of the Navy's budget, this number is even more remarkable when viewed through the lens of continued personnel reductions, which started before the events of September 11, 2001; as planned, the enlisted end strength for the USN will decrease from 305,735 in 2005 to 285,605 in 2007[3].

Table 1. 2005-2006 Enlisted End Strength.

	FY 2005 Actual	FY 2006 Planned	FY 2007 Planned
Average Strength	372,256	352,729	346,759
End Strength	362,941	352,700	340,700
Authorized End Strength	365,900	352,700	

Source: DON FY2007 *Budgeting Estimates*

As the USN transitions through these personnel draw downs, the need for enlisted communities to manage their manpower resources effectively will increase. The cliché, "do more with less," could be applied to the USN requirement to continue to fulfill its mission obligations with fewer personnel. The continuing GWOT and arising geo-political tensions in Asia and the Arabian Gulf indicate that the mission demand placed on Navy personnel could increase in the near future. Couple this with the fact that the

[2] Department of the Navy Budget Office, "Providing the Right Force Today," Washington, DC: Department of the Navy, 2006, 34.

[3] Department of the Navy Budget Office, "Budgeting Estimates," Washington, DC: Department of the Navy, 2006, 23.

total number of combat ships in the Navy is planned to increase from 383 to 385 from 2005 to 2007,[4] as shown in Table 2, and the need for proper personnel management by the Navy becomes critical.

Table 2. Navy Battle Force Ships.

Battle Force Ships			
	FY 2005	**FY 2006**	**FY 2007**
Aircraft Carriers *	12	12	11
Fleet Ballistic Missile Submarines	14	14	14
Guided Missile (SSGN) Submarines	4	4	4
Surface Combatants	99	102	106
Nuclear Attack Submarines	54	55	52
Amphibious Warfare Ships	34	33	34
Combat Logistics Ships	30	30	32
Mine Warfare Ships	17	16	14
Support Ships	17	17	18
Battle Force Ships	**281**	**283**	**285**

Source: Department of the Navy Budget Office. *Providing the Right Force Today*

One enlisted community is already feeling the stress of the Navy's "Force Transformation." In June of 2006, the Advanced Electronic Guidance Information System (AEGIS) Fire Controlmen (FC) community had a deficit of 173 unfilled E-5 sea

[4] Department of the Navy Chief of Naval Operations, "Chief of Naval Operations Guidance 2004," Washington, DC: Department of the Navy, 2004.

duty requirements, yet, at the same time, they had a surplus of 252 E-5[5] personnel on shore duty. The total number of AEGIS FC personnel needed was presented; the billet structure and promotion windows placed them in a position where they could not meet their sea-shore distribution needs. With the previously discussed Navy "force transformation" underway, it is apparent that Navy communities could use an aging model to predict what effects community management policy changes may have in the future. There is never a good time to have a misalignment of personnel, but in an era of personnel draw-downs, the Navy cannot afford to place personnel where they are not needed.

The creation of a community aging model based on a Population Matrix model may allow the AEGIS FC community and other enlisted communities to accurately forecast future year force and community structure. An accurate aging model could allow community managers and manpower planners to decrease the number of misfit personnel within the Navy billet structure. By decreasing the number of misaligned personnel, enlisted communities will be better prepared to meet the requirements of the "transformed" USN. In the words of the Chief of Naval Operations, "We must get a better handle on our manpower requirements, including the requirements for accession, training and placement of the total workforce of active duty, reserves, civilians and contractors. We must improve our use of modeling, develop and improve output metrics to better define our requirements and resource needs, and instill a culture of improved productivity in everything we do."[6] An accurate aging model could provide an improved planning tool.

B. OBJECTIVES

This thesis will develop an aging model based upon Population Matrix modeling methods with Markov properties. This aging model will use retention, accession, and

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[5] AEGIS FC data is from the Enlisted Master File in June 2005.

[6] Department of the Navy Chief of Naval Operations. Chief of Naval Operations Guidance 2004. Washington, DC: Department of the Navy, 2004.

attrition data for varying paygrades and year groups within the AEGIS FC community to predict the personnel structure of the future FC AEGIS community. This thesis addresses the following questions:

- Can an accurate community aging model be used to predict the effect that community-management decisions will have upon an enlisted community?

- Are the current community-management procedures and polices for the AEGIS FC community effective in meeting the AEGIS FC billet demands?

- Could alternative AEGIS FC community-management procedures and polices improve the AEGIS FC community's ability to meet their billet demands?

C. SCOPE

This research will include: (1) an overview of the AEGIS FC community structure;(2) a summary of current business practices used for personnel forecasting in the Navy; (3) identification of community management policies that govern the AEGIS FC community; (4) development of AEGIS FC progression, retention, and attrition rates by paygrade and years in service; and (5) development of a community aging model incorporating the information detailed in the above items.

The transition matrix for the Population Matrix model will use data provided by the AEGIS FC community manager. AEGIS FC progression, retention and attrition rates were derived from datum contained in the Enlisted Master File.

D. ORGANIZATION OF STUDY

Chapter II discusses the structure of the AEGIS FC community, details the current AEGIS FC community management planning policies and procedures. The current AEGIS FC personnel billet distribution is presented and the problems facing the AEGIS FC community are outlined. Chapter III describes the methodology used to build the community aging model using the Population Matrix method with Markov properties.

Chapter IV provides results as predicted by the community aging model. Chapter V presents conclusions and recommends further areas of research needed to extend this study.

II. AEGIS FC COMMUNITY

A. AEGIS FC SKILL SET AND FUNCTION

As one of two Navy ratings considered to be in the advanced electronics and computer field (Electronics Technicians ET being the other), FC AEGIS personnel are given extensive training in AEGIS electronics, AEGIS computer systems, AEGIS radars, AEGIS communications systems, and AEGIS weapons fire control systems. Due to the technical nature of the AEGIS FC rating, the entrance requirements for all accessions are set at a high level. All prospective AEGIS FCs must score a combined minimum of 223[7] in the ASVAB fields of Arithmetic Reasoning (AR), Math Knowledge (MK), Electronics Information (EI) and General Science (GS). In addition, each candidate must be a United States citizen and pass a security check and physical.[8] Due to the technical nature and length of the AEGIS FC training pipeline, most candidates are 3rd class petty officers (E-4) before receiving orders to the fleet.

Beyond the initial AEGIS FC training, there are several Navy Enlisted Codes (NEC) that are a part of the AEGIS FC community. Each NEC denotes specialized training in an AEGIS FC area. The following list shows the NEC number and area of specialized training for each AEGIS FC NEC.

- FC-1104: AEGIS Combat System (BL4) Maintenance Supervisor
- FC-1105: AEGIS Weapon System MK-7 Technician
- FC-1106: AEGIS Fire Control System MK-99/Operational Readiness Test System MK-1 Technician
- FC-1107: AEGIS Radar System (SPY-1A) Technician
- FC-1108: AEGIS Weapon System MK-7 Technician
- FC-1115: AEGIS Combat System Display Maintenance Technician

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[7] This is as of June 24, 2006.

[8] Phone conference with FC community manager, June 24, 2006.

- FC-1118: AEGIS Display Technician (CG 60-DDG 58)
- FC-1119: AEGIS Radar System (SPY-1B/D) Technician
- FC-1143: AEGIS Fire Control System MK-99/Operational Test System MK-1 Technician
- FC-1144: AEGIS Combat System (BL 4) Computer System Maintenance Technician[9]

These NECs demonstrate the complexity and highly technical nature of the AEGIS FC community and how their skill sets play in the operation of the USN AEGIS ship classes. This background reinforces the need for a properly manned complement of AEGIS FC personnel aboard each AEGIS ship.

B. AEGIS FC COMMUNITY STRUCTURE AND COMMUNITY MANAGEMENT POLICIES

The Enlisted Master File indicates the USN AEGIS FC community consists of approximately 2,144[10] personnel broken down into the paygrades of E-1 to E-9. Their FY 2006 Enlisted Personnel Authorized (EPA) is 2,014, meaning that the AEGIS FC community is actually over-manned at 106%.[11] Table 3 demonstrates the AEGIS FC community's personnel and EPA broken down by paygrade.

Table 3. AEGIS FC Community

2006	E1-3	E-4	E-5	E-6	E-7	E-8	E-9	Total
Personnel	37	636	695	516	34	68	58	2144
EPA	0	720	621	398	61	23	91	2014
Personnel / EPA	0%	88%	112%	130%	3%	269%	64%	106.45%

Source: Enlisted Master File

[9] NAVPERS NEC Excerpt.

[10] All AEGIS FC figures were pulled from the Enlisted Master File, June 2006.

[11] 106% = June 2006 AEGIS FC inventory / 2006 AEGIS FC EPA.

From an aggregate manning perspective the AEGIS FC community appears to be doing well. With 130 personnel above EPA, the AEGIS FC community should be able to meet its billet demands at both sea and shore.

The AEGIS FC sea billet structure consists of 1,402 sea duty billets, 359 shore duty billets and 248 Individuals Account billets. [12] The total sea/shore/IA AEGIS FC billet demand of 2,009 gives no initial indication of potential shortfalls. With a 6% aggregate manning surplus, the AEGIS FC community should be capable of filling the 2,009 sea/shore/IA billets with 135 AEGIS FC personnel to spare. In this case, however, "all that glistens is not gold."

When the AEGIS FC billet demand structure is broken down into paygrades, the manning problems within the AEGIS FC community becomes more apparent. Table 4, which breaks down the sea duty personnel shortfalls and surpluses by paygrade, shows that sea duty is manned at 94.2%.[13]

Table 4. AEGIS FC Sea Billet / Personnel.

Sea Duty	E1-3	E-4	E-5	E-6	E-7	E-8	E-9	Total
Personnel	29	567	344	241	70	40	30	1321
Billets	0	533	517	222	55	0	75	1402
Surplus / Short Fall	29	34	-173	19	15	40	-45	-81

Source: Enlisted Master File

There are only two paygrade shortfalls, E-5 and E-9, the greatest shortfall being E-5. Inversely, Table 5 shows the largest surplus of shore duty personnel is currently at the E-5 level.

[12] IA is Students plus Personnel in Transients, Patients, Prisoners, and Holdies (TPPH).

[13] 94.2% = 1321 current AEGIS FC personnel assigned to sea billets / 1402 sea AEGIS FC billets.

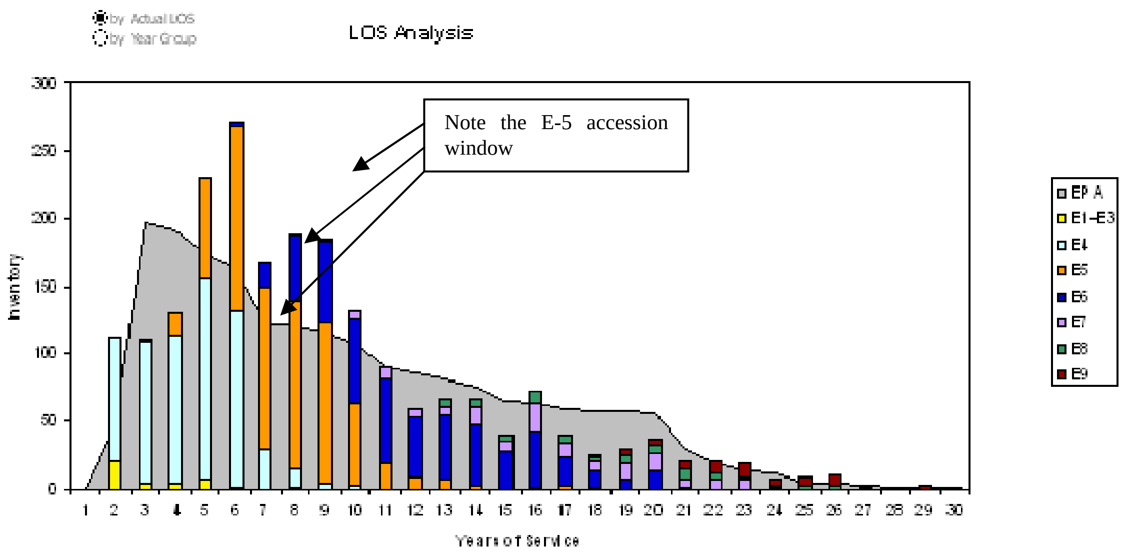
Table 5. AEGIS FC Shore Billet / Personnel.

Shore Billets	E1-3	E-4	E-5	E-6	E-7	E-8	E-9	Total
Personnel	1	52	317	229	56	23	27	705
Billets	0	6	65	163	89	19	17	359
Surplus/ Shortfall	1	46	252	66	-33	4	10	346

Source: Enlisted Master File

An 81 AEGIS FC personnel shortfall at sea duty and a 346 AEGIS FC personnel surplus on shore duty is, in effect, leaving gapped billets at the "tip of the spear" where the USN needs its AEGIS FC personnel the most.

The determining factor in the AEGIS FC community structure and its billet manning is its community management policies. Following their initial AEGIS FC training, service members are given 54-month sea duty orders. During this initial sea tour, the majority of AEGIS FC personnel are ether E-3 or E-4. AEGIS FC personnel begin to promote to E-5 at four years of service with the majority of E-5 ascensions taking place at five and six years of service. Figure 1 graphically shows the current AEGIS FC personnel distribution by years of service.

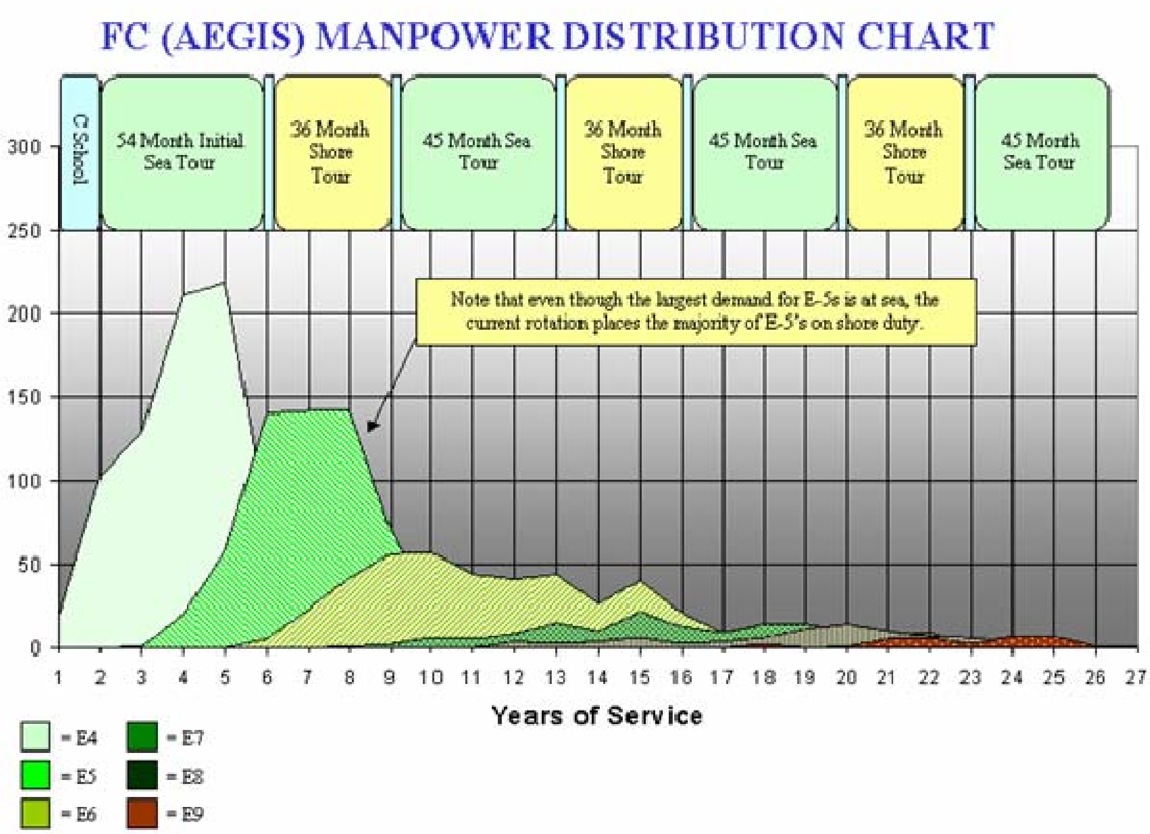


Source: Enlisted Digital Dashboard

Figure 1. AEGIS FC Length of Service Analysis.

It appears that the current AEGIS FC sea-shore rotation policy has generated the over-manning of E-5 AEGIS FC personnel on shore duty (over by 252), while the fleet is experiencing a shortfall (under 173). The total number needed to properly man the fleet with E-5 AEGIS FC personnel is available. Nevertheless, the current promotion windows and sea-shore rotation policies prevent the AEGIS FC detailers from being able to send E-5 AEGIS FC personnel to where they are most needed. Figure 2 combines the sea-shore rotation of a typical FC AEGIS career path with the current[14] AEGIS FC personnel represented by years of service to graphically demonstrate the location of their current sea-shore rotation AEGIS FC personnel

[14] June 2006, EMF data.



Source: Enlisted Master File

Figure 2. AEGIS FC Manpower Distribution Chart.

The factors presented in Chapter I indicate enlisted communities need to increase their effectiveness in utilizing their personnel. In the words of Admiral Clark,

> While we recognize that people are our most treasured asset, manpower is never free. We must be committed to building a Navy that can maximize the capability of our people and minimize the total number on the payroll. Sailors have chosen the lifestyle of service to make a difference. Our ability to provide them meaningful, challenging work and the kind of job content that lets them make that difference is part of our covenant with them as leaders. It enhances their growth and development, improves their productivity and eliminates unnecessary billets. As our Navy becomes more high tech, our work force will get smaller and smarter. We will

> spend whatever it takes to equip and enable our Sailors, but we do not want to spend one extra penny for manpower we do not need.[15]

This thesis will evaluate whether the AEGIS FC community can improve their ability to meet billet demands by altering their current community-management policies. The following chapter will provide a model to evaluate the impact of adjustments to sea-shore policy changes on the manning levels within the AEGIS FC community.

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[15] Department of the Navy Chief of Naval Operations. Chief of Naval Operations Guidance 2004. Washington, DC: Department of the Navy, 2004.

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III. METHODOLOGY

A. POPULATION MATRIX AND MARKOV MODEL FORMULATION

This chapter outlines the Population Matrix method with Markov properties, which was used to develop the community-aging model.

Historically, Population Matrix models have been used by bioresearch experts to predict the population ecology of endangered species. Several government agencies have sponsored population matrix models for endangered species. This thesis drew upon the research and modeling methods used by several such studies.[16]

If a Population Matrix model can be used to predict the changes within a limited endangered species population then it should be able to predict the changes within a limited human population — a population like the Navy's AEGIS FC community. Additionally, the inclusion of Markov principles within each submatrix of the Population Matrix model should increase the overall accuracy of AEGIS FC Aging Model.

Markov processes are indispensable to probability analyses. Markovian models rely upon a chain of random values whose probabilities at a point in time depend upon the value of the number at a previous point in time. These steady state models depend upon the assumption that there is a finite number of outcomes, all dependent upon the history of past outcomes. In other words, discrete patterns or behaviors will eventually evolve. If a researcher can identify the independent variables that influence these patterns, the probability of the potential outcomes can be determined. The transition probability, or the conditions that drive a system to arrive at a defined new state, is controlling factor in a Markov chain.

[16] The Population Matrix studies are listed in the bibliography section.

In “Modeling and Analysis of Stochastic Systems,” Kulkarni details how Markov chains can be applied to predictions of outcomes in a variety of fields ranging from genetics to telecommunications. By using the Markov modeling method within each cell of the population matrix, the AEGIS FC aging model will be developed.

1. Model Data

AEGIS FC data was pulled from the Enlisted Master File in June of 2006. The Enlisted Master File is the primary database utilized by the U.S. Navy for enlisted data. The quality of the data in the Enlisted Master File is dependent upon manual entries from personnel responsible for entering enlisted gain-loss data, and is subject to transpositional error. Actual figures and data in the system can differ due to time delays in entering new data, system maintenance, and human error. As with any model, the accuracy of AEGIS FC Aging Model is dependent upon the quality of the data being used.

The decision was made to use only variables available in the Enlisted Digital Dashboard for the development of the AEGIS FC aging model. These variables included retention, promotion, attrition, and accession rates. The rationale behind this decision was to allow the AEGIS FC aging model to remain useful to the enlisted AEGIS FC community in the future. There must be a means for the state-to-state transition variables to be modified by AEGIS FC enlisted detailers and community managers. To facilitate this capability, the rates available in the Enlisted Digital Dashboard were used in the development of the AEGIS FC aging model. Limiting the variables to those available in the Enlisted Digital Dashboard, however, will reduce the accuracy of the AEGIS FC aging model; significant variables (such as gender, age, and education) were left out intentionally because the detailers and community managers who will utilize the AEGIS FC aging model do not have readily available access to these variables.

a. The Data Sets

For the AEGIS FC aging model, four state-to-state transitions were identified: (1) Personnel could transition from Year Group to Year Group in increments of +1 (but never –1); (2) personnel could transition from paygrade to paygrade in increments of +1 (but never –1); (3) personnel could transition out of the system; and (4) personnel could transition into the system. The Model data sets were derived in support of modeling the four listed state-to-state transitions.

The following section defines the data sets used in the development of the AEGIS FC aging model:

PAYGRADE: a system denoting rate and indicates the rate at which a member receives basic pay, commonly referred to as "rank." For the enlisted service members, paygrade is broken into nine categories from E-1 to E-9.

Years of Service (YOS): Indicates the years a service member has served in the military. YOS is also referred to as Length of Service (LOS).

Attrition: Indicates personnel who leave the AEGIS FC community.

Attrition Rate: Indicates the historical rate the AEGIS FC community loses its people. This rate is supplied in the Enlisted Digital Dashboard.

Accessions: Indicates the number of personnel who enter the AEGIS FC community.

Promotion Rate: Indicates the historical rate each paygrade promotes to the next paygrade. This rate is supplied in the Enlisted Digital Dashboard.

Retention Rate: Indicates the historical rate the AEGIS FC community retains its personnel. This rate is sub divided into three "zones." Zone A: Service members between one and six YOS; Zone B: Service members between six and ten YOS; and Zone C: service members between ten and fourteen YOS. This rate is supplied in the Enlisted Digital Dashboard.

Inventory: Indicates the number of AEGIS FC personnel in each paygrade within the AEGIS FC community. This initial inventory (or stock) was derived from Enlisted Master File Data.

B. MARKOV MODEL TRANSITION MATRIX

Markov models are classified into ether finite or infinite chains according to whether the state-to-state transition is finite or infinite. Finite Markov models have a finite number of states an individual can exist in, and infinite Markov models have an infinite number of states. Since the AEGIS FC aging model has a finite number of states an individual can exist in (Years of Service and Paygrade), it is classified as a finite Markov model.

Mathematically represented, a Markov model is

$$P(X_{n+1} = j | X_0 = i_0, X_1 = i_1, \cdots, X_n = i) = P(X_{n+1} = j | X_n = i) =: P_{ij}(n).$$

Where

(X_n) = Markov Chain

$P_{ij}(n)$ = State to State Transition Probability from, state i to state j. Where P is a stochastic process

This mathematical representation demonstrates the process that occurs within each transition submatrix within the overall Population Matrix model of the AEGIS FC aging model. The probability (P) of transition from one state to another state is affected by the transition variables (X). In laymen's terms the probability of a service member promoting, attrition from the system, or remaining at the same paygrade is directly influenced by the values entered for promotion rate, reenlistment rate, and attrition rate.

The finite AEGIS FC aging model utilizes these transition probability submatrices are based upon the Markov model to build the Population Matrix model. The main body of the Population Matrix model is divided into submatrices based on years of service and paygrade. To calculate transition probabilities, each submatrix must be isolated. To isolate the submatrix each was composed of a set of rows and columns containing paygrades from E-4 through E-9. The row provides the stock of personnel at a given rank (and given year of service) at the beginning of the year. Each row consists of probabilities of personnel moving from one paygrade to another paygrade in the model. Personnel will stay at current rank, move up one rank, move up one year of service, or exit the system based on calculated transition probabilities.

Figure 3 shows how personnel at the one year of service, E-4 submatrix, will transition to two years of service as ether E-5, E-4, or exit the system.

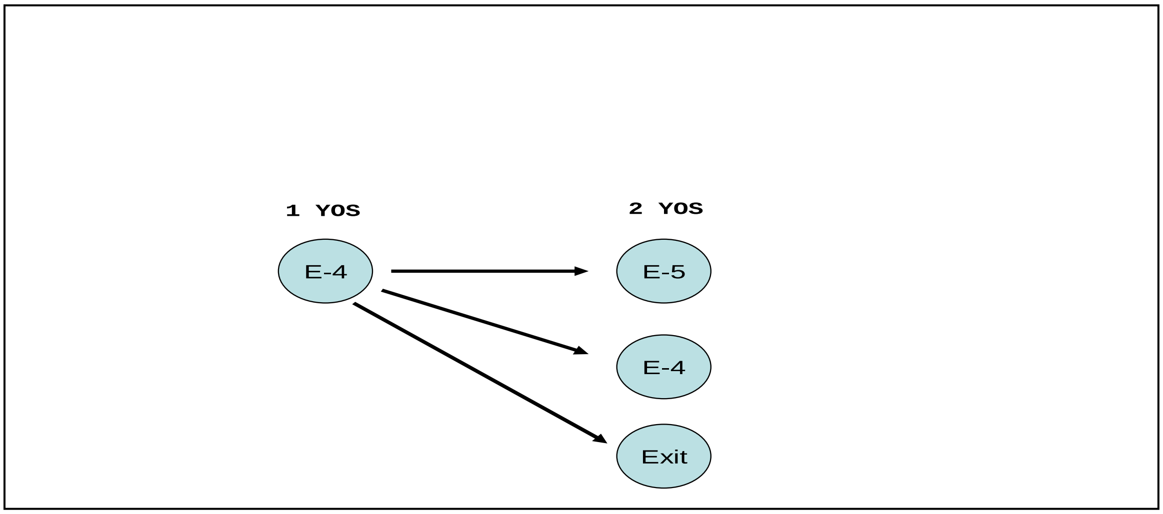

Figure 3. Submatrix Transition.

Within the AEGIS FC aging model this process will continue through each submatrix cell per annual cycle. Illustration 3.2 shows a transition from one year of service E-4 to two years of service with ether E-4, E-5 or exit the system, which occurs concurrently with a transition from E-4 and E-5 with two years of service to E-4, E-5, E-6 or exit the system with three years of service. Note that in the AEGIS FC aging model this process occurs within every submatrix cell at the same time. For every annual cycle each submatrix cell will run its individual transition probabilities at the same time as all other submatrix cells.

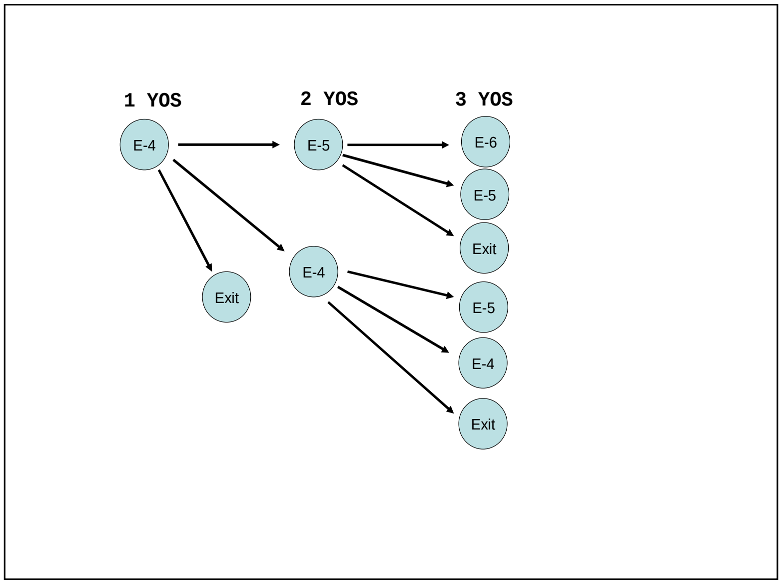

Figure 4. Multi YOS Transition Matrix.

To calculate the probabilities of grade changes as a function of years of service and paygrade of an individual, the Enlisted Digital Dashboard counted the number of observed instances an individual at a particular year of service and grade were promoted, remained at the same grade, or exited the matrix.

1. Inventory (Stock)

The initial AEGIS FC stock values were developed for each paygrade and years of service by using the Enlisted Master File data. The initial stock values are provided in Chapter IV: Results. The first step was to ensure that each record had a year of service value. Accessions from Year One were added into the model at the beginning of Year Two as individuals with one year of service. This process is repeated for each predicted year. The model time horizon is seven years. This means that for each year of service and grade category, seven predicted years are calculated using the AEGIS FC aging mode. A seven-year time horizon was chosen as a result of interviews with enlisted detailers and community managers. Due to personnel turnover and frequent policy changes, the consensus was any predictions past seven years would be of little use.

A summary is provided for each year in the model, which shows totals for yearly stock by paygrade broken down into years of service.

2. Output

The output worksheet in the model presents results for forecasted values that were derived for personnel who flowed through the model. The values produced in the output section are stock values for each paygrade and years of service. These results are further summarized at the bottom of the worksheet and show the totals for individual paygrades broken down by predicted year and paygrade.

C. AEGIS FC AGING MODEL TEST

To quality check the AEGIS FC aging model, a test was preformed using historical data from fiscal year 2000. Stock at time zero was taken from actual fiscal year 2000 Enlisted Master File data. The theory behind the test was to push the actual fiscal year 2000 data through the AEGIS FC aging model to obtain the prediction outputs. Once the output was obtained, a comparison to the actual fiscal year 2006 Enlisted Master File data was performed. The results of this test are outlined in Chapter IV.

D. SUMMARY

Population matrix methodology was utilized to develop and test an accurate yet useable AEGIS FC aging model. This model tests possible alternative manning structures for the AEGIS FC community. By manipulation of a user-friendly interface, the variables of promotion rate by paygrade, retention, attrition, initial inventory (stock), and accessions can be manipulated.

Variables were limited to those available to the AEGIS FC detailers and community managers through the Enlisted Digital Dashboard. While this limitation decreased the accuracy of the AEGIS FC aging model by leaving significant variables out of the model, this was an accepted degradation in exchange for the gained value and usability of the AEGIS FC aging model to the detailers and community managers.

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IV. RESULTS

A. POPULATION MATRIX AND MARKOV MODEL BASED AEGIS FC AGING MODEL

The following chapter outlines the quantitative results of the AEGIS FC aging model. Scenarios were based on issues facing AEGIS enlisted community managers and enlisted detailers. The scenarios are for this thesis only and do not represent current Navy business practices. All data used in scenarios was drawn from the Enlisted Master File and Enlisted Digital Dashboard from July of 2006.

1. Model Validation

This section will demonstrate how the validation test for the AEGIS FC aging model was performed. The validation test utilized variables based on mean historical values from FY1995 to FY2000.

a. Transition Variables

To validate the AEGIS FC Aging Model, fiscal year 1995 to 2000 Enlisted Master File and Enlisted Digital Dashboard data was used.

2. FY2000 Initial Stock

Initial FY2000 stock was pulled from the Enlisted Master File. Table 6 shows the initial stock by paygrade and years of service.

Table 6. Initial FY2000 Stock.

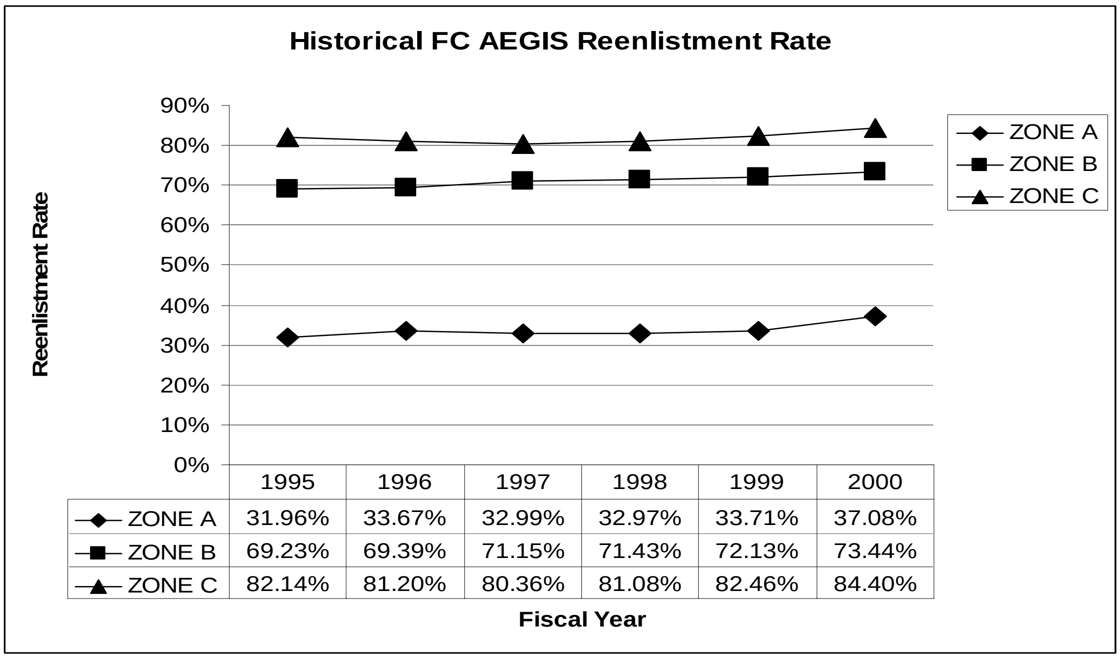
Length Of Service	PAYGRADE							
	E-3	E-4	E-5	E-6	E-7	E-8	E-9	Total
1	0	0	0	0	0	0	0	0
2	19	56	0	0	0	0	0	75
3	16	233	8	0	0	0	0	257
4	8	118	60	0	0	0	0	186
5	1	37	145	0	0	0	0	183
6	0	8	85	1	0	0	0	94
7	0	13	60	10	0	0	0	83
8	0	2	46	11	0	0	0	59
9	0	2	49	14	1	0	0	66
10	0	1	43	30	1	0	0	75
11	0	0	14	15	3	0	0	32
12	0	0	6	29	1	0	0	36
13	0	0	3	31	11	0	0	45
14	0	0	0	21	16	1	0	38
15	0	0	2	32	32	1	1	68
16	0	0	2	25	26	4	0	57
17	0	0	0	18	27	5	1	51
18	0	0	2	17	37	6	1	63
19	0	0	0	11	39	11	4	65
20	0	0	0	12	23	7	3	45
21	0	0	0	1	7	6	3	17
22	0	0	0	0	2	4	4	10
23	0	0	0	0	1	4	3	8
24	0	0	0	0	1	3	7	11
25	0	0	0	0	0	2	4	6
26	0	0	0	0	0	0	1	1
27	0	0	0	0	0	0	1	1
28	0	0	0	0	0	0	1	1
29	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	0	0
Total	44	470	525	278	228	54	35	1634

3. FY2000 Retention Variables

The retention rate variables were based on Enlisted Digital Dashboard data from FY1994 to FY2000. The retention rate variables for Zones A, B, and C were based on the mean of Zone A, B, and C retention rates.

Table 7 shows the historical data used to derive the reenlistment variables.[17]

Table 7. Historical FC AEGIS Reenlistment Rate.



	1995	1996	1997	1998	1999	2000
ZONE A	31.96%	33.67%	32.99%	32.97%	33.71%	37.08%
ZONE B	69.23%	69.39%	71.15%	71.43%	72.13%	73.44%
ZONE C	82.14%	81.20%	80.36%	81.08%	82.46%	84.40%

[17] Data pulled from the Enlisted Master File.

Table 8. Group One Mean AEGIS FC Reenlistment Variables.

ZONE A		*ZONE B*		*ZONE C*	
Mean	0.3373	Mean	0.7113	Mean	0.8194
Standard Error	0.0072	Standard Error	0.0066	Standard Error	0.0058
Median	0.3333	Median	0.7129	Median	0.8167
Standard Deviation	0.0176	Standard Deviation	0.0162	Standard Deviation	0.0143
Sample Variance	0.0003	Sample Variance	0.0003	Sample Variance	0.0002
Range	0.0512	Range	0.0421	Range	0.0405
Minimum	0.3196	Minimum	0.6923	Minimum	0.8036
Maximum	0.3708	Maximum	0.7344	Maximum	0.8440
Sum	2.0238	Sum	4.2677	Sum	4.9164
Count	6	Count	6	Count	6
Mean	33.73%	Mean	0.711282649	Mean	0.819396

4. FY2000 Promotion Rate Variable

The promotion rate variables were based on Enlisted Master File and Enlisted Digital Dashboard data from FY1994 to FY2000. The promotion variables were based on the mean promotion rates.

Table 9 shows the historical used to derive the first group of promotion variables.

Table 9. Historical AEGIS FC Promotion Rates.

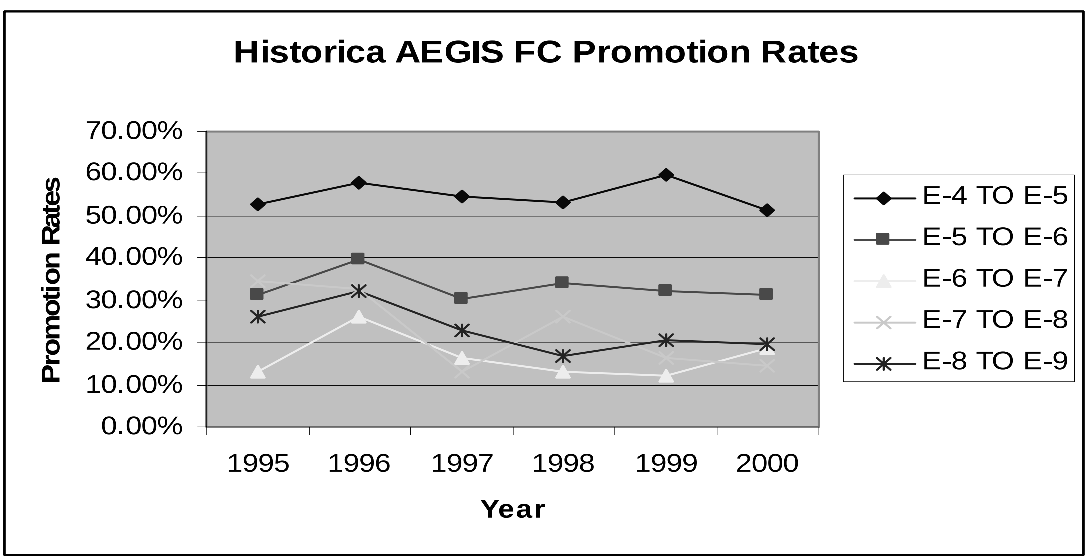


Table 10. Group One Mean AEGIS FC Promotion Variables.

E-4 TO E-5		*E-5 TO E-6*		*E-6 TO E-7*		*E-7 TO E-8*		*E-8 TO E-9*	
Mean	0.5491	Mean	0.3319	Mean	0.1669	Mean	0.2295	Mean	0.2304
Standard Error	0.0134	Standard Error	0.0137	Standard Error	0.0218	Standard Error	0.0391	Standard Error	0.0228
Median	0.5378	Median	0.3193	Median	0.1480	Median	0.2140	Median	0.2170
Standard Deviation	0.0327	Standard Deviation	0.0335	Standard Deviation	0.0534	Standard Deviation	0.0958	Standard Deviation	0.0559
Range	0.0851	Range	0.0902	Range	0.1410	Range	0.2159	Range	0.1571
Minimum	0.5143	Minimum	0.3044	Minimum	0.1226	Minimum	0.1316	Minimum	0.1671
Maximum	0.5994	Maximum	0.3946	Maximum	0.2636	Maximum	0.3475	Maximum	0.3242
Sum	3.2944	Sum	1.9915	Sum	1.0016	Sum	1.3772	Sum	1.3823
Count	6.0000	Count	6.0000	Count	6.0000	Count	6.0000	Count	6.0000
Mean	*54.91%*	*Mean*	*33.19%*	*Mean*	*16.69%*	*Mean*	*22.95%*	*Mean*	*23.04%*

5. FY2000 Accession Rate Variable

The Accession rate variables were based on Enlisted Master File and Enlisted Digital Dashboard data from FY1995 to FY2000. The accession variables were based on the mean accession rates. The second group of accession variables was based on the actual FY2000 promotion rates.

Table 11 shows the historical data used to derive the first group of accession variables

Table 11. Historical AEGIS FC Accessions.

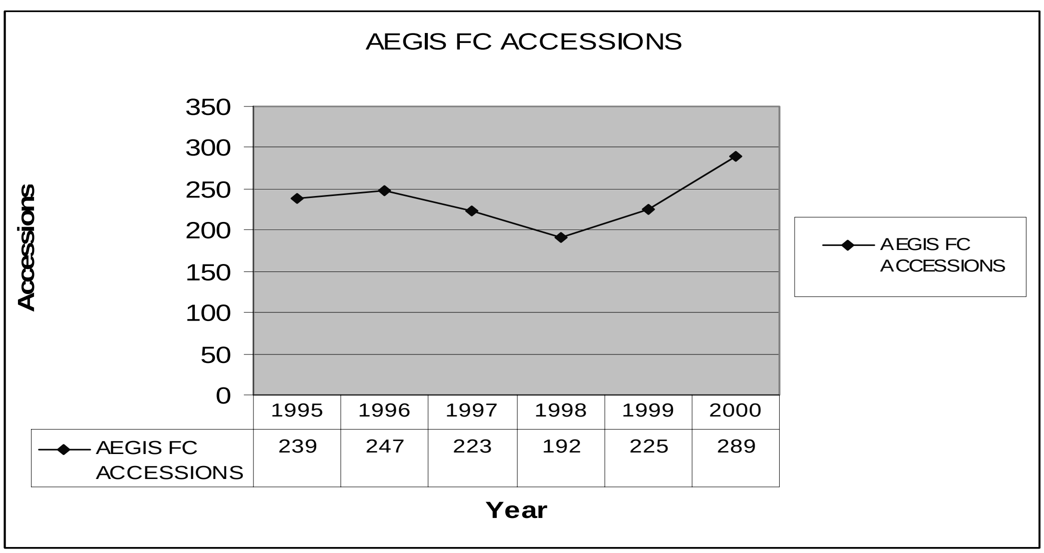


Table 12. Mean AEGIS FC Accession Variable.

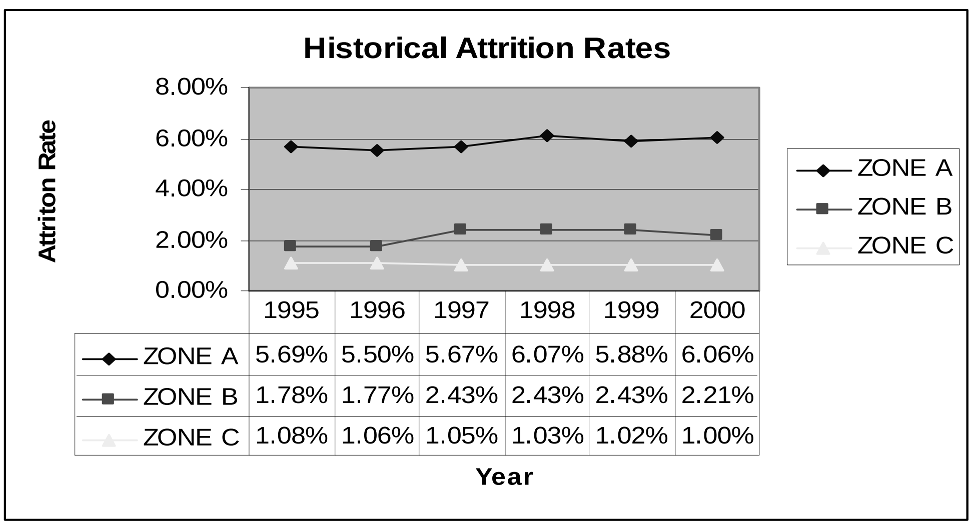
AEGIS FC ACCESSIONS	
Mean	235.8333
Standard Error	13.1210
Median	232.0000
Standard Deviation	32.1398
Sample Variance	1032.9667
Range	97.0000
Minimum	192.0000
Maximum	289.0000
Sum	1415.0000
Count	6.0000
Mean	235.8333

6. FY2000 Attrition Rate Variable

The attrition rate variables were based on Enlisted Master File and Enlisted Digital Dashboard data from FY1995 to FY2000. The attrition variables were based on the mean attrition rates.

Table 13 shows the historical data used to derive the first group of accession variables.

Table 13. Historical AEGIS FC Attrition Rates.



	1995	1996	1997	1998	1999	2000
ZONE A	5.69%	5.50%	5.67%	6.07%	5.88%	6.06%
ZONE B	1.78%	1.77%	2.43%	2.43%	2.43%	2.21%
ZONE C	1.08%	1.06%	1.05%	1.03%	1.02%	1.00%

Table 14. Mean AEGIS FC Attrition Variables.

ZONE A		ZONE B		ZONE C	
Mean	0.0581	Mean	0.0218	Mean	0.0104
Standard Error	0.0009	Standard Error	0.0013	Standard Error	0.0001
Median	0.0579	Median	0.0232	Median	0.0104
Standard Deviation	0.0023	Standard Deviation	0.0032	Standard Deviation	0.0003
Range	0.0058	Range	0.0066	Range	0.0008
Minimum	0.0550	Minimum	0.0177	Minimum	0.0100
Maximum	0.0607	Maximum	0.0243	Maximum	0.0108
Sum	0.3488	Sum	0.1307	Sum	0.0623
Count	6.0000	Count	6.0000	Count	6.0000
Mean	*5.81%*	*Mean*	*2.18%*	*Mean*	*1.04%*

a. Performing Validation Test

The validation test was performed under the assumption the AEGIS FC aging model will be used as a predictor of future AEGIS FC force structure. A logical validation test under this assumption would be to run the AEGIS FC aging model using historical data then, compare the model's prediction to the actual current FY data.

The validation test for the AEGIS FC aging model's prediction utilized the FY 2000 stock values and mean variables from FY 1995 to FY2000. The model was allowed to predict the future AEGIS FC force structure for six annual cycles (FY2000 to FY2006). The AEGIS FC aging model's prediction was then compared to the actual AEGIS FC force structure in FY 2006 to obtain the accuracy of the AEGIS FC aging model's prediction; as with any model, the accuracy of the AEGIS FC aging model will be dependent upon the quality of the data used in the transition variables.

7. Validation Testing of the AEGIS FC Model

The validation test used FY1995 to FY2000 mean transition variables and FY 2000 initial stock. The AEGIS FC aging model was allowed to predict six annual cycles, simulating the aging progress of the AEGIS FC community from FY2000 to FY2006.

Table 15 shows the initial FY2000 stock AEGIS FC community structure, Table 15 shows the FY2006 predicted AEGIS FC aging model output and Table 11 shows the FY2006 AEGIS FC community structure.

Table 15. FY 2000 AEGIS Community Structure.

	Pay Grade							
YOS	E-3	E-4	E5	E6	E7	E8	E9	Total
1	235	0	0	0	0	0	0	0
2	19	56	0	0	0	0	0	56
3	16	233	8	0	0	0	0	241
4	8	118	60	0	0	0	0	178
5	1	37	145	0	0	0	0	182
6	0	8	85	1	0	0	0	94
7	0	13	60	10	0	0	0	83
8	0	2	46	11	0	0	0	59
9	0	2	49	14	1	0	0	66
10	0	1	43	30	1	0	0	75
11	0	0	14	15	3	0	0	32
12	0	0	6	29	1	0	0	36
13	0	0	3	31	11	0	0	45
14	0	0	0	21	16	1	0	38
15	0	0	2	32	32	1	1	68
16	0	0	2	25	26	4	0	57
17	0	0	0	18	27	5	1	51
18	0	0	2	17	37	6	1	63
19	0	0	0	11	39	11	4	65
20	0	0	0	12	23	7	3	45
21	0	0	0	1	7	6	3	17
22	0	0	0	0	2	4	4	10
23	0	0	0	0	1	4	3	8
24	0	0	0	0	1	3	7	11
25	0	0	0	0	0	2	4	6
TOTAL	279	470	525	278	228	54	31	1586

Table 16. FY2006 AEGIS FC Aging Model Output.

	Pay Grade							
YOS	E-3	E-4	E5	E6	E7	E8	E9	Total
1	235							235
2	7	262						269
3	0	113	144					257
4	0	47	153					200
5	0	19	122					141
6	0	8	88	41				137
7	0	1	45	54				100
8	0	0	9	18				27
9		0	27	77	12			117
10		0	16	60	18			93
11			8	51	24			83
12			3	26	15	3		47
13			4	28	17	6		54
14			2	19	13	5		39
15			2	16	12	6		36
16			2	18	14	8		42
17			1	8	7	5	1	22
18			0	9	9	6	2	26
19			0	7	9	8	5	28
20			0	4	6	7	6	22
21				7	5	7	7	26
22					4	6	7	17
23					1	2	3	6
24					1	2	5	8
25					1	3	7	10
TOTAL	242	451	626	442	166	72	42	2041
Actual	FY2006	783	635	425	155	76	50	2124
Actual	FY2000	470	525	278	228	54	31	1586

Table 17. FY2006 AEGIS FC Community Structure.

	ACTUAL FY 2006 AEGIS FC STRUCTURE						
YOS	E-4	E5	E6	E7	E8	E9	Total
1	0	0	0	0	0	0	0
2	72	0	0	0	0	0	72
3	95	1	0	0	0	0	96
4	162	3	0	0	0	0	165
5	230	36	0	0	0	0	266
6	170	98	1	0	0	0	269
7	29	139	7	0	0	0	175
8	15	158	30	0	0	0	203
9	6	117	51	2	0	0	176
10	4	49	61	9	0	0	123
11	0	11	63	7	0	0	81
12	0	10	36	5	1	0	52
13	0	8	36	14	5	0	63
14	0	2	34	11	4	0	51
15	0	2	28	17	4	0	51
16	0	1	38	20	4	0	63
17	0	0	15	10	3	0	28
18	0	0	7	10	4	0	21
19	0	0	8	15	11	3	37
20	0	0	10	14	12	6	42
21	0	0	0	7	9	8	24
22	0	0	0	7	7	10	24
23	0	0	0	7	6	6	19
24	0	0	0	0	2	8	10
25	0	0	0	0	4	9	13
TOTAL	783	635	425	155	76	50	2124

2. Validation Test Accuracy

To measure the "accuracy" of the validation test, a table of confusion was used. In this case

Accuracy (Model) = AV / AV + V

Where
AV = Actual Value, this is the actual # of FC members in 2006
V = Variance, this is the difference between the AV and the predicted # of FC members in 2006.

Table 18 shows the “accuracy” of the validation test by sum totals per paygrade.

Table 18. Validation Test Accuracy By Paygrade.

FY2006	E-4	E-5	E-6	E-7	E-8	E-9	Total
Predicted	451	626	442	166	72	42	2041
Actual	783	635	425	155	76	50	2124
Variance	332	9	17	11	4	8	83
Accuracy	70.2%	98.6%	96.2%	93.4%	95.0%	86.2%	96.2%

As shown in Table 18, the accuracy of the AEGIS FC Aging Model initially indicates varying accuracy levels for predicting future FC community structure based on sum total paygrade numbers for all paygrades, while the accuracy for E-5, E-6, E-7, and E-9 are within 10%, E-8 is 86.2% and E-4 is 70.2%.

The 70.2% accuracy value for E-4 can be explained, the annual accession variable was set by the mean accession data from FY1995 to FY2000. The mean accession variable being 235.8 accessions per year; the AEGIS FC Aging Model therefore uses 236 (235.8 rounded) per year for the six annual cycles (FY2000 to FY2006). In actuality, in FY 2003 to FY 2005 the AEGIS FC community had a large rise in their accessions, FY2003 being 374, FY2004 being 355, and FY2005 being 301 accessions. These accessions count for 322 individuals that the AEGIS FC Aging Model did not predict. Compare the 322 members to the 332 variance between the AEGIS FC Aging Models prediction and the actual FY2006 E-4 population, and there is only a variance of ten.

While the AEGIS FC Aging Model demonstrated at fairly high level of accuracy in predicting total sums of AEGIS FC members broken down by paygrade, it fell short when predicting the total sums of AEGIS FC members broken down by years of service. Table 19 shows the “accuracy” of the validation test by years of service.

Table 19. Validation Test Accuracy by YOS.

YOS	Predicted FY2006	Actual FY2006	Variance	Accuracy
1	235	0	235	0.0%
2	269	72	197	57.7%
3	257	96	161	61.5%
4	200	165	35	85.1%
5	141	266	125	53.0%
6	137	269	132	50.9%
7	100	175	75	57.1%
8	27	203	176	13.3%
9	117	176	59	66.5%
10	93	123	30	75.6%
11	83	81	2	97.6%
12	47	52	5	90.4%
13	54	63	9	85.7%
14	39	51	12	76.5%
15	36	51	15	70.6%
16	42	63	21	66.7%
17	22	28	6	78.6%
18	26	21	5	83.9%
19	28	37	9	75.7%
20	22	42	20	52.4%
21	26	24	2	92.9%
22	17	24	7	70.8%
23	6	19	13	31.6%
24	8	10	2	80.0%
25	10	13	3	76.9%
TOTAL	2042	2124	82	96.1%

8. Model Inaccuracies

The inaccuracy of the AEGIS FC Aging Models prediction based on YOS is an indicator of a problem inherent in Population Matrix prediction models. There is a tendency for the model to drift towards a “steady state.”

In the “real world” the AEGIS FC community does not drift towards a steady state. A plethora of influences upon the AEGIS FC community structure are not accounted for in the AEGIS FC Aging Model. In the AEGIS FC community, each individual has varying abilities and talents. They do not all advance or attrite at the same rate. Each year the promotion, attrition, accession, and other variables change, based on real-world influences. The AEGIS FC Aging Model, by its nature, uses the entered variables for each year. For example, if the promotion rate for E-4 is set to 54%, then the model will predict the future AEGIS FC force structure using an E-4 promotion rate of 54% for every year. This means that every E-4 in the model will promote at a 54% rate.

B. SUMMARY

The validation test indicated the AEGIS FC Aging Model's sum total predictions by paygrade for E-5 through E-8 were accurate to within 10% of actual 2006 AEGIS FC sum totals. The E-9 sum total prediction accuracy was 86.2%, the small population pool (there are only fifty E-9 AEGIS FCs in 2006) making a prediction within 10% accuracy difficult. The 70.2% accuracy for E-4 sum total was linked to the real-world fluctuations in accessions that the AEGIS FC Aging Model did not take into account. While not the perfect prediction tool, the validation test indicated the AEGIS FC Aging model can give an accurate prediction of future AEGIS FC community structure based on sum totals.

The validation test also indicated that the AEGIS FC Aging Model was inaccurate in predicting the AEGIS FC communities structure based on years of service and paygrade. The AEGIS FC Aging Model's prediction drifted towards a steady state; historically the AEGIS FC community has never reached a steady state. Consequently, the model's prediction will always, eventually, reach a steady state and the real AEGIS FC community will never reach a steady state. The simple fact is the AEGIS FC Aging Model will never accurately predict the future AEGIS FC community based on years of service and paygrade.

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V. CONCLUSION AND RECOMMENDATION

A. POPULATION MATRIX WITH MARKOV PROPERTIES

The AEGIS FC Aging Model validation test demonstrated that the model can be accurate in the aggregate when predicting AEGIS FC community dynamics based on the adjustable variables. The validation test also demonstrated the model's shortcomings in predicting community structure based on years of service and paygrade. This limitation was linked to the model's tendency to drift towards a steady state. Unlike the AEGIS FC Aging Model the real AEGIS FC community is dynamic, with a plethora of influences impacting upon it. The sterile environment of the prediction model could never fully account for the real-world influences that shape the AEGIS FC community.

While the AEGIS FC Aging Model has limitations, it demonstrated that a Population Matrix can be applied to a limited human population. As with a limited bio-population, the AEGIS FC community demonstrated similar dynamics of growth and population survival.

B. RECOMMENDATIONS

Population Matrix models have been well established by bioresearches in predicting the population dynamics of endangered species. This thesis has shown that when a Population Matrix is used in conjunction with Markov principles, under the proper circumstances, it can predict limited human population.

The recommendation for future studies is to use Population Matrix principles to build upon this thesis. While the AEGIS FC Aging Model demonstrated that limited human population dynamics can be predicted using Population Matrix principles, it was also shown to have limitations predicting AEGIS FC community dynamics based on years of service. The ideal goal of future studies would be to develop a model that could predict community dynamics in both rank and years of service, while remaining useable to the community detailers and community managers.

C. LESSONS LEARNED

The Navy is dynamic, and its manpower goals and policies change on a regular basis. While this thesis was being researched and written, the Navy personnel who were contacted for inputs or shown the AEGIS FC Aging Model for review have all either received or executed orders; this led to the decision to make the AEGIS FC Aging Model "user friendly." Many of the detailers and community managers are going to have very little if any knowledge or training on models or how to use them. For any model to retain usefulness for a community, it must be understandable to laymen, and those same laymen must be able to train their successors on the proper use of the model. If the model fails on either its ability to be understood by a layman or trained by the same laymen to their successor, then it will fail to be turned over to the next series of AEGIS FC detailers and community managers.

The challenge of this thesis was not to build a model that could predict AEGIS FC community dynamics. Population Matrix models have been used to predict community dynamics for a plethora of animal, plant and human populations. The academic world is awash with population and prediction models. The true challenge of this thesis and any future studies is to develop a model that can demonstrate a level of accuracy while remaining useful to the customers. This requires tradeoffs, even intentionally leaving out relevant predictors and data,[18] to ensure that the final model will be useful to the customer. Remember that once you leave the world of academia, many will have little if any understanding of modeling processes.

D. SUMMARY

This thesis posed three questions:

- Can an accurate community aging model be used to predict the effect that community-management decisions will have upon an enlisted community?

[18] In this thesis the model was limited to the data that's available to the AEGIS FC detailers and community managers through the Enlisted Digital Dashboard.

- Are the current community-management procedures and polices for the AEGIS FC community effective in meeting the AEGIS FC billet demands?
- Could alternative AEGIS FC community-management procedures and polices improve the AEGIS FC community's ability to meet their billet demands?

Can an accurate community aging model be used to predict the effect that community-management decisions will have upon an enlisted community? This thesis has shown that an accurate community aging model can be used to predict community dynamics. It also demonstrated that there are limitations inherent in aging models.

Are the current community-management procedures and polices for the AEGIS FC community effective in meeting the AEGIS FC billet demands? This thesis has shown that the current community-management procedures are not effective in meeting the AEGIS FC billet demands. There is a large imbalance of AEGIS FC service members being stationed ashore and those stationed at sea. This problem is critical at the E-5 level.

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BIBLIOGRAPHY

Chief of Naval Personnel. Naval Military Personnel Manual. Millington, TN: Department of the Navy, 2007.

Director Force Transformation. Military Transformation a Strategic Approach. Washington, DC: Office of the Secretary of Defense, 2003.

Director Force Transformation. Elements of Defense Transformation. Washington, DC: Office of the Secretary of Defense, 2003.

Department of the Navy Budget Office. Providing the Right Force Today. Washington, DC: Department of the Navy, 2006.

Department of the Navy Budget Office. FY2007 Budgeting Estimates. Washington, DC: Department of the Navy, 2006.

Director, Manpower, Personnel Training and Education (MPT&E) Policy Division (N13.) MANUAL OF NAVY ENLISTED MANPOWER AND PERSONNEL CLASSIFICATIONS AND OCCUPATIONAL STANDARDS MANUAL Volume II. Millington, TN: Department of the Navy, 2007.

Department of the Navy Chief of Naval Operations. Chief of Naval Operations Guidance 2004. Washington, DC: Department of the Navy, 2004.

Gotell, N., & Ellison, A. Forecasting Extension Risk with Nonstationary Matrix Models. Harvard Forest, MA: Harvard University, 2006.

King, A, Mann, L., Dale, V., & Ashwood, T. Assessing the Persistence of an Avian Population in a Managed Landscape: A Case Study With Henslow's Sparrow at Fort Knox, KY. Oak Ridge, TN: Oak Ridge National Laboratory, 1998.

Kulkarni, V. Modeling and Analysis of Stochastic Systems. New York: Chapman and Hall, 1995.

Li, C., & Schreiber, S. Dispersal and Population Growth for Multistate Matrix Models. Williamsburg, VA: College of William and Marry, 2006.

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